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There appears to be an open question between Professor Ormond Stone, of Cincinnati, and Mr. Rock, of Washington, as to whether the nucleus of Comet b, 1881, divided on the night of the 6th instant.

Both astronomers appear to have observed the comet at the same time, but have recorded somewhat different results.

On reference to "Science," July 16th, page 334, will be found a statement of what Mr. Rock saw, as follows:

On the 6th of July the comet was observed by Mr. Rock of the Naval Observatory:

"A bright tongue of light about one revolution long in direction of tail, with a slight node near end and curved."

In explanation of this Mr. Rock said: "I observed the comet at the time of its lower culmination about twenty minutes after midnight. The nucleus did not appear to be divided, but a bright band streamed out in the direction of the tail. This band was about fifteen seconds of the arc in length. Near the end of it was a bright spot, and that portion of the band extending beyond it was curved in the same general direction as the tail, but in a somewhat shorter arc."

And then referring to Professor Stone's report of a division of the nucleus, he adds:

"It is possible that the observer at Cincinnati was not able to distinguish the band of light which I saw uniting the nucleus and the node, and so concluded that he saw two nuclei. When I first observed the comet, on June 28, the coma was apparently homogeneous as it also was on July 2. On June 28, however, there were two spurs of light spreading away from the opposite sides of the head like angel's wings. On July 2, I did not observe these at all or they were very faint. On July 6, I observed the appearance that I have described. It may be that this was the same thing that I saw on June 28, observed from a different point of view. It is not improbable, however, that the nucleus has really divided. Comets appear to have a tendency to do that."

In another part of this issue will be found a letter from Professor Stone, reiterating his former claim of having observed a division of the nucleus of this comet on the night of the 6th instant.

"He states that on the 6th of July, during observations made between 10 p. m. and 3 a. m., he saw a bright red jet projected from the nucleus into the dark region on the side of the nucleus opposite the fan, which was totally different in appearance from those usually seen. There was a dark line separating it from the nucleus. During the first few minutes a decided change took place. The jet *seemed to separate* and form a nucleus of its own, so that for a time the comet appeared double."

It may assist in a solution of this subject if our readers inspect the continuation of the interesting drawings of this comet, made by Professor Edward S. Holden, to be found on another page of this issue.*

The drawings we published last week showed the appearance of the comet on 24th, 25th, 26th, 27th, 28th and 29th of June, and the nights of the 8th and 11th of July. Those presented in this number give views of the comet for the nights of the 13th, 14th, 17th and 18th of July.

The drawing for the 11th of July is interesting as showing "a dark narrow channel between the following side of the nucleus, and the envelopes," but, added Professor Holden, "the nucleus is not double." But the drawing we offer this week for the 18th instant, is quite remarkable as showing a decided division of the nucleus, and Professor Holden remarks in his note to it, "The nucleus is double (it has not been previously)," and those who inspect this drawing will find two nuclei.

The drawings of Professor Holden and the observations of all who have watched this comet, show conclusively that the form of the nucleus changed very rapidly and continuously, and as we have the best evidence that the nucleus divided on the 18th instant, it makes it very probable that a similar phenomenon occurred on the 6th of the same month, especially as Professor Stone is an accomplished observer, and not likely to be mistaken in his description of the optical appearance of a celestial object.

An experiment illustrating "fatigue" in the sense of hearing (corresponding to fatigue of the retina) has been described by Herr Urbantschitsch. Two tubes are adapted to the ears, and adjusted, so that a given tuning-fork is heard equally on both sides. Now strike the fork strongly, and let it sound a little through one tube; then deaden it somewhat by touching. The ear on that side fails to catch the weakened sound, but on transferring the fork to the other ear, the sound is heard distinctly. If the weaker tone presented be of different pitch from the stronger, it is heard on both sides equally. The failure of sensitiveness in the other case is very transient.

* On account of delay in engraving these drawings, they are reserved until next week's issue.

LATENT SOLAR LIGHT.*

Translated from the French, by the Marchioness CLARA LANZA.

A remarkable stone, which plays quite an important role in ancient history, is the carbuncle, literally translated, glowing coal, which shines and glimmers in the dark. Lucien relates that in the Temple of Hieropolis there is the statue of a Syrian goddess in whose forehead is placed a stone called *lychins* or lamp. This stone was moderately brilliant during the day, but at night it illuminated the temple from one end to the other. Shakespeare, in Titus Andronicus, says, while speaking of Prince Bassianus' body:

> "Upon his bloody finger, he doth wear
> A precious ring, that lightens all the hole,
> Which, like a taper in some monument,
> Doth shine upon the dead man's earthy cheeks."

It is said that formerly dwarfs and gnomes wore one of these stones upon their heads as miners carried their lamps. We have likewise been told that certain birds knew where to find them and make use of them to illumine their nests. The tendency which has been remarked in birds, notably crows, to pick up brilliant objects, has naturally given rise to numerous legends and anecdotes among all people, and it is declared that in America numbers of birds light up their nests by placing therein fire-flies. The carbuncle has still another secret property, for it renders the object it adorns, invisible both to man and beast. The question may therefore properly arise, how did man happen to discover this treasure which birds alone were apparently able to distinguish? Poetic fancy, we may say, has answered this query. The invisibility is caused by a ray of light which blinds the eye. A mirror, however, does not become so easily dazzled, and if, while walking along the edge of a brook, you perceive the reflection of a nest in the water, while with your naked eye you are unable to discover it, you may be sure that the stone is there. The legend of the carbuncle first arose in India, the land of precious stones, and it was founded upon the remarkable capacity possessed by many diamonds and a few rubies of shining for a long time in the dark after being exposed a few moments to the sun or merely broad day-light. This phenomenon appears to have been studied and experimented upon for the first time in Europe somewhere about the seventeenth century, by the celebrated naturalist, Boyle. In India, however, the knowledge of it can be traced back to the furthest antiquity, as can be proved by referring to a passage in the famous drama called *Sakuntala*, whose author certainly lived long before the beginning of our era. The passage is this:

"Among the just whose souls enjoy the most complete repose, there is a hidden radiance, which illumines them with its faint glimmer. Thus shines the precious sun stone, as soon as an outward ray of light strikes it."

At Bologna, which, as we know, is a well-known scientific centre, there lived at the beginning of the seventeenth century, a shoemaker named Vincenzo Cascariolo, who like many other men of his time, determined to discover primitive matter in the shape of the philosopher's stone, and by means of it, change the vilest and most worthless metals into pure gold. He had already experimented with fire and water upon all possible substances, organic and inorganic, when in 1604, some writers say 1612, he found, one day upon Mount Paderno, close to his own dwelling, a grayish-white stone, of a fibrous structure, and whose weight being considerable, made him suspect some unusual property. He calcinated a portion of it with some coal, and night falling while he was engaged in the operation, he saw with utter stupefaction, that the entire contents of his crucible, shone with a ruddy glow, although the furnace had become quite cold. With trembling hands he seized the stone, not doubting in the least that it was the famous philosophical one, of which he had so long been in search—still less did he doubt, when he observed afterwards, that only the fragments which were exposed to the sun or broad daylight were brilliant. Alchemists in those days called the sun a golden planet. In their works they employed an identical sign to designate both the luminary and the metal, and they firmly believed that the rays of the former penetrated the latter, as water is soaked into a sponge. This mysterious connection is clearly indicated in a brief opuscule discovered during the middle ages, no one knows exactly where, and of which there exists now only a Latin translation, the original, however, doubtless having been found in some Egyptian tomb. It is called "The Emerald Table of Hermes Trismegistus," and among other things it is therein stated that "the father of the Philosopher's Stone, is the sun, its mother the moon. Separate the earth from fire, and you will obtain the wonder of the world, all shadows will flee before you." These obscure words were applied to the new luminous body called phosphorus, and the phosphorescent stone of Bologna, excited the young disciples of chemistry, to the highest pitch of interest.

Although this substance did not at once realize the great expectations set abroad concerning it, and notwithstanding the fact that it was obliged to renounce entirely the *rôle* of philosopher's stone, it nevertheless caused its discoverer to make a considerable sum of money, for men seeking knowledge and instruction came from all countries to Bologna, and purchased this natural curiosity to a great extent. Poets likewise wrote laudatory Latin verses to the now celebrated shoemaker, comparing him to Prometheus who stole fire from heaven, and placed it on the earth. Enormous enthusiasm was manifested everywhere for this remarkable stone. Volumes were written about it, and it was even stated that the sun and moon were nothing more than huge masses of Bologna phosphorus. For a long time it was thought that the stone existed nowhere but at Bologna, but later it was discovered that it was composed principally of spar or sulphate of baryta, which was to be found in numerous places.

Alchemists gathered fresh hope in 1674, when Christian Balduinus, intendant at Grosenhain in Saxony obtained an analogous luminous body by the calcination of nitrate of lime. He called it hermetic phosphorus or solar gold, and in several works he declared that this was indeed the veritable philosopher's stone whose properties he was engaged in studying. The only German Naturalistic Society at that period was the "Leopold Academy of Natural Curiosities," and this organization received the new inventor into their midst under the honored title of Hermes, which has ever remained in the chemical world. Since then, it has always been supposed that the hermetic or philosophical stone must be luminous, and Dickinson, physician to Charles II, of England, relates in his "Old Physical Truths" (1702) that Noah, whom he regarded as one of the ancestors of hermetic science, had placed a large gleaming stone of some sort, called *zohar* in Hebrew, upon the top of his ark, so that he might have perpetual light during the night, and that moreover the scientific knowledge of this same Noah had caused him to nourish every animal in the ark with an extract made from the meat or plant which the creature preferred, thus economizing space and doing away with the necessity of removing from the ark such bones, leaves, skins, etc., which might otherwise have been there.

Chemical researches advanced with singular activity; for about the same time that Balduinus was performing his experiments, Brand, of Hamburg, an obstinate investigator discovered a substance which produced luminous vapor, and condensed itself into yellow drops that shone in the dark without being exposed to the sun. Professor Kirchmayer, of Wurtemburg, announced to

* This article was originally written in German and published a short time ago in the *Gartenlaube*.

the world emphatically, that the long sought for "perpetual light" had at last been found, while another enthusiastic novice wrote a work upon the *Phosphorus mirabilis* and its marvellous brilliancy. Here again the future did not justify all the hopes which might have been expected. This substance, however, which still goes by the name of phosphorus has become one of the necessities of our age.

Phosphorus gradually entered the scientific period. In 1768 an English chemist, Canton, obtained a new kind by calcinating oyster shells with sulphur, and it was finally discovered that the best absorbents of light were combinations of sulphur, calcium, baryum and strontium. However, other metallic sulphurets and various substances are equally capable of making in the dark what is called solar, magnetic or electric light. The method of preparation, of course, has considerable influence and lights of divers colors can be obtained according to the process employed. By calcinating sulphates with organic substances, or carbonates with sulphur, a very brilliant phosphorus can be obtained, consisting principally of baryta, another of lime, less luminous and a third of strontium, which gives forth a very feeble light. Sulphate of baryta gives a phosphorescent product of an orange color. When the sulphate is prepared artificially the light is greenish.

Later, Ozarm obtained other luminous bodies by calcinating lime with sulphate of arsenic or sulphate of antimony, while another chemist, Bach, by heating sulphur with calcinated oyster shells which had probably been washed with a solution of ammoniac and realgar, procured a phosphorus so brilliant that its light was even visible during the day.

It is by this means, or others which are similar, that the luminous flowers are prepared which lately have appeared to such an extent. They are covered with some phosphorescent substance which makes them glimmer in the dark with a beautiful bluish light. The luminous matter is pulverized and applied to the object by means of a varnish or anything else that will stick. By employing phosphorus of different colors very pretty effects can be produced, bouquets of all shades, glittering butterflies, luminous inscriptions, etc. But the most interesting of all is undoubtedly luminous photography, which is made by placing a paper covered with phosphorescent powder behind the glass negative of a photograph. Heat brings out the luminous qualities as well as light, and very peculiar and beautiful effects can be obtained by writing upon such a paper as has just been described with a pointed piece of heated metal.

Unfortunately these interesting amusements are not eligible as regards trade, for as soon as it is exposed to the air sulphuric luminous matter gradually loses its properties and acquires the disagreeable odor of spoiled eggs, while the object by the end of a week or two is not phosphorescent at all. On the other hand, it can be very well preserved by putting it into air-tight glass tubes, and phosphorus of all colors thus prepared can be had from Geissler's establishment in Bonn. It has been proposed to make inscriptions of these tubes for the night bells of hotels, physicians' houses and druggists' shops, the daylight being sufficient to make them very luminous at night. Another idea, conceived by Gustave Ullig, is to make the faces of watches and clocks phosphorescent, as the glass covering them would be a protection against destruction.

As to the physical explanation of phosphorescence, it was thought for a long time that the light was composed of little eddies or whirlpools of subtile matter, and that sunlight became condensed and accumulated in them. Later, when it was known that light is only a vibratory movement, and that the phosphorus on the end of matches only burns because it is united with the oxide in the air, it was thought that in all the old phosphorescent substances the light was produced alone under the influence of a slight oxidation. This explanation, however, is false, and only during the last century was the true one made known by a celebrated German physician named Euler.

It is generally believed that the planets, the tops of mountains, and all celestial bodies, are visible, simply because they reflect the rays of the sun. This is also false. Brilliant surfaces alone, more or less, reflect light, others absorb it on the contrary, and cause vibration just as a musical sound makes all the objects which it strikes vibrate. Certain surfaces, however, can only reproduce certain vibrations (blue or red for example) of solar light, which is composed of the vibrations of the seven prismatic colors, and when these vibrations are repeated in our eye, the surfaces appear to us blue or red, as the case may be.

In the same way that consecutive vibrations can be determined after sound, so phosphorescence succeeds the action of light. Euler affirmed that the greater number of bodies would present these luminous vibrations if they were observed immediately after they had been exposed to the sun, and if a continued sitting in the dark had rendered the eyes of the observer very sensible. The French physician, Becquerel, constructed an instrument about twenty years ago called the phosphoroscope, by means of which he demonstrated that most substances, paper, stone, oyster shells, etc., shone for a short time after being exposed to the light, that is to say, a second or the fraction of a second, and that solar phosphorus was only distinguishable from other bodies by the persistence of this property. But whether this assertion be true, generally speaking, or not, the subject itself is not by any means simple, and there are a mass of circumstances of which we must take account.

Modern physics teach us that a number of bodies, notably colored organic matter and some metallic combinations, become phosphorescent, but only when they are lighted. This sounds like a paradox, but facts can prove the assertion. There are certain substances, both liquid and solid, which by reflected light appear to have another color than the one transmitted. A peculiar emission of rays can also be observed upon the surface. Petroleum, solutions of sulphate of quinine, decoctions of Indian bark, etc., emit bluish rays; the etherized extract of green leaves, blood red rays; uranium glass, which is pale green and used principally in the manufacture of Rhine wine glasses, emits reddish yellow rays. If any of these dichroic subtances are selected and placed in a dark room lighted only by an electric current traversing a glass tube, they will shine brilliantly, each one in its particular color, certainly with more splendor than the electric light, and yet only while the latter illumines them. How is this curious phenomenon to be explained? How can a feeble light produce such a brilliant one?

It has been said above that white light is composed of seven colors, or, more properly speaking, of an infinite number of colors, which after their dispersion from the prism separate one from the other and form a long band. The red rays are those which vibrate the slowest, and the violets those which vibrate the most rapidly. But just as there are in addition to the red rays others which vibrate slower still and are manifested not as luminous rays, but calorific ones, so there are besides the violets, ultra violet rays which vibrate so quickly that we cannot directly perceive them, although they are known by their energetic chemical action. This is notably the case in photography, and for this reason they are termed chemical rays, or invisible light. A pale, electric light, is a peculiarity of these rays, and the latter give to certain bodies that remarkable dichroic radiance which has been called fluorescence, because it was observed for the first time in fluor-spath. However, if on one side these rays produce a light which cannot be perceived by our retina owing to the extreme rapidity of their vibrations, on the other, the bodies thus illuminated should be able to

diminish the rapidity by vibrating themselves more slowly, and thus render the rays visible. Ultra violet rays could consequently be transformed into violet, blue or green; blue rays into yellow or red. What generally happens, however, is that they change red rays to purely calorific ones and thus make them invisible.

We must here make several important observations. First of all, violet rays do not only produce the greatest fluorescence, but also the greatest phosphorescence. Red rays produce neither the one nor the other. Luminous or dichroic substances give a light differing from that which they receive. It has been demonstrated, finally, that the closest relationship exists between the two phenomena—That fluorescence can be considered as an intense phosphorescence which can be seen in broad daylight, but which dies with the light which gave it birth, while phosphorescence is only a feeble but persistent fluorescence.

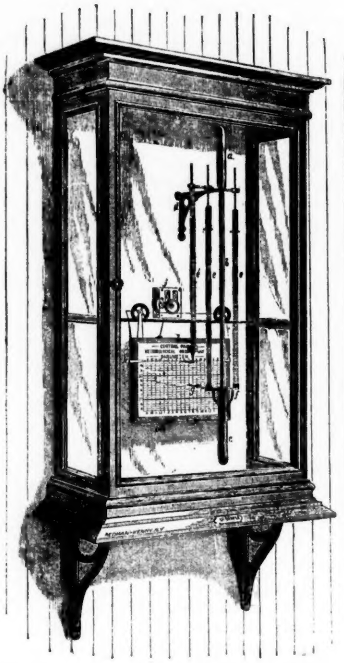
"Solar phosphorus" generally reproduces luminous vibrations even when it has ceased to receive the latter, and it can transform calorific rays into luminous ones. A diamond acts in this way, also fluor-spath, and nearly all artificial phosphorus. One of the last named gives forth a light of various colors, if it is heated to different degrees after being exposed to the light. Sulphate of strontium produces a deep purple light at 20°, a violet light at 15°, blue at 40°, bluish-green at 70°, greenish-yellow at 100°, and reddish-yellow at 200°,

Moreover, phosphorescence, like fluorescence, can be produced by means of an electric light rich in chemical rays. If you expose to such a light a flower, a butterfly or any other object covered with phosphorescent powder, it will assume a magnificent appearance. The English chemist, Crookes, prepared diamonds and rubies in this way, by enclosing them in an air-tight glass ball placed in the immediate vicinity of the negative pole, from which a luminous current issued. The effect was superb, recalling all sorts of fairy stories. Some African diamonds shone with a brilliant blue light, and a large greenish one produced such an intense radiance that it almost looked like a lighted candle. In fact the light was quite sufficient to read by, and the history of that famous stone in the Temple of Hieropolis seemed really probable. A collection of small diamonds from various countries, placed in any receptacle that is air-tight, will produce parti-colored fiery lights, blue, pink, red, orange, yellow, green and pale green, all mingling together.

In a third recipient, Crookes placed a quantity of uncut rubies, which, when the electric light fell upon them shone with such a gorgeous red flame that they appeared to be incandescent. Artificial rubies prepared by Feil in Paris gave as brilliant a light as the real ones, and white crystals became rose-colored or deep red. Such wonderful carbuncles would have astonished even the authors of the old legends.

A CURIOUS thing occurred lately in the works of M. Fleury, at Cette (Hérault). The feed-water of the boiler giving much incrustation, M. Fleury was advised to put into the boiler some fragments of zinc as a de-incrustant, and did so. In a few days, spite of oiling, the steam-engine began to work very badly, the piston catching a great deal, and it soon became necessary to stop and make examination. The piston was found to be covered with a thick adherent layer of copper. It was put on the lathe, and at certain ovalised points, the metallic layers were so thick that the tool worked in copper alone. The explanation given by M. Fleury is this: The boiler was connected with the engine by copper pipes. Particles of zinc carried off by the steam would form with the copper numberless small galvanic couples; hence the transport of copper to the piston, which would principally attract them by reason of its motion, and of the heating produced. It is remarked in *Les Mondes*, that the eminently electric properties of expanding steam may have helped in development of the phenomenon.

DRAPER'S SELF-RECORDING, MERCURIAL BAROMETER.



We are indebted to Dr. Daniel Draper for preparing an abstract of his weekly Meteorological report for this journal, the third of which appears this day in another column.

Dr. D. Draper is director of the Meteorological Observatory of the Department of Public Works, Central Park, where all observations are made by self-recording instruments, especially designed and arranged for this purpose.

The great object Dr. Draper had in view when designing these instruments, was to combine simplicity of construction with perfect efficiency. His great success is well known to all familiar with Meteorological Science, and we propose in the course of a few articles to fully describe these instruments, and illustrate the subject with excellent wood cuts.

We commence the series with a description of the apparatus for recording Barometric observations.

"I was led to construct this form of barometer from the fact that with the photographic one it cannot be told what the atmospheric fluctuations are until the next morning, when the photographic plate is developed. Even then, if there has been much variation in temperature, it alters the sensitiveness of the collodion film, so that it is very difficult to read the tracing. The construction of the pencil instrument is as follows:

In the pencil barometer the glass tube is 36 inches in length, the upper portion being of larger diameter than the lower; it is held firmly in a fixed position, and filled in the usual manner with quicksilver; its lower or open end dips into a tube or reservoir containing the same metal. This reservoir is suspended on two spiral steel springs, and has freedom of motion up and down. When the pressure of the atmosphere diminishes, a portion of the mercury flows out of the tube into the reservoir; this becoming heavier, stretches the steel springs, causing the ink pencil fastened to them to mark downwards. If the pressure increases the reverse movement takes place. The ink pencil makes its mark on a ruled paper register,

carried at the rate of half an inch per hour from right to left by a clock.

There is a third steel spring of the same length and strength as those on the reservoir, stretched by a weight to a distance equivalent to 30 inches on the barometer scale. The object of this spring is to give the correction of temperature for those sustaining the reservoir. The register paper should always be set to the same line on which the pencil of this spring marks.

The movements of the mercury on the register can be magnified to any required extent by increasing the length of the spiral springs. In this instrument it is multiplying twice.

DESCRIPTION OF INSTRUMENT.

The tube marked *a b* is of glass; the upper part is of a larger diameter than the stem, *a* being ¾ of an inch internal diameter and 10 inches long, while the stem, *b*, is ⅛ of an inch bore and 26 inches long. The total length of the tube is therefore 36 inches. The reservoir, *c*, is suspended from a brass frame, *d*, fastened to the back of the case. This frame also holds the upper ends of the steel springs, *e*, *e*, *é*. The glass reservoir, *c*, is of the same diameter and length as the upper part of the tube, *a*; on its open end is turned a flange to hold it in a brass frame, *f*, to which are fastened the lower ends of the steel springs, *e e*; it also carries an ink pencil, *g*, that touches the ruled paper on the board *h h*, which is drawn aside by the clock, *i*. The spring, *é*, is for the correction of temperature on the other springs. Heat has a slight effect on them, causing them to lengthen about $\frac{1}{16}$ of an inch from 90 degrees Fahr.; to allow for this, the third spring, *é*, is weighted with a lead weight and pencil, it marks its fluctuations on the upper line of the register sheet. In this manner this instrument gives the correction for temperature (or reduction to 32°) from the fact that it weighs the mercury instead of measuring its length, which is affected by heat.

Ink pencils of the barometer and other instruments are made by drawing narrow glass tubing to a fine point, which lightly touches the paper register, leaving a mark of red ink that has been diluted with about one quarter of its volume of glycerine. The glycerine prevents the ink from drying too rapidly. The advantage of this form of pencil over lead ones is that it requires little or no pressure to produce a mark.

To receive the atmospheric fluctuations a suitable ruled paper is fastened by means of small brass clamps, *k k*, to the board, *h h*, which is hung by rollers to the thick steel rod fastened to the sides of the case, on which the paper is carried from right to left by the clock, *i*, at the rate of ½ an inch per hour, by means of the pulley on the hour arbor of the clock. The wire that connects the register board to the clock is soft steel, number 28 wire gauge; having only one turn round the pulley it readily slips so that the board can be pushed sideways for the adjustment of time, or for the renewal of the sheet of paper."

ON AN OCCURRENCE OF GOLD IN MAINE.*

By M. E. Wadsworth.

The gold under consideration here is found on Seward's Island, a small island in the town of Sullivan, Hancock County. The gold is found in quartz veins cutting an eruptive mass of diabase. This diabase forms a dike of about forty feet in thickness, lying approximately parallel to the bedding of an indurated fine-grained argillaceous mica schist; all dipping nearly S. 30° W., 24° to 42°. The dip averages about 35°, and the strike is far from being uniform. Crossing the diabase at various angles, but generally from north to south, are segregated quartz veins. In some places the rock is a confused reticulated mass of these veins, with patches of diabase lying between them. The veins vary in width from a mere seam to even a foot in breadth. Starting where only one or a few of them are visible, they gradually increase in number, until they become quite numerous, while they will doubtless be found to fade away as they began. The diabase and schists are cut by several dikes of diabase running approximately at right angles to the strike of the schist, or parallel to the veins. The vein stone is quartz, together with some calcite, tremolite and chlorite, and carries tetradymite and gold.

So far as examination has been made, the veins in the diabase carry gold, and the decomposed diabase immediately adjacent to the quartz veins also contains that metal to a greater or less extent. The gold occurs principally in small grains in the vein in conection with the tetradymite, bits of decomposed diabase, and in the cavernous portions, but not in the compact quartz of the vein itself. The tetradymite is in irregular grains and masses, showing a brilliant metallic lustre, and a well-marked basal cleavage. The locality is worked for it gold, and was visited by the writer in December last

Cambridge, Mass.

*From the *Bulletin of the Museum of Comparative Zoology*.—Harvard College.

ELEMENTS AND EPHEMERIS OF COMET (*c*), 1881.—SCHÆBERLE.

The elements and ephemeris of the comet, given below, are those computed at the observatory of Lord Crawford, at Dun Echt, Scotland, and cabled to the *Science Observer* by means of the code adapted by S. C. Chandler, Jr., and John Ritchie, Jr.

ELEMENTS.

Perihelion Passage, 1881, Aug. 21^{d}.50. Greenwich Mean Time.

	°	′	
Long. Perihelion	= 218	45	Eq. 1881. 0.
Dist. Perihelion from Node	= 121	9	
Long. Node	= 97	36	
Inclination	= 140	37	

log. Perihelion Distance, 9.8069.

EPHEMERIS.

Greenwich midnight 1881.	R.A. h.	m.	s.	Decl. °	′
Aug. 3	6	43	4	+ 47	46
7	7	11	24	50	11
11	7	54	56	52	20
15	8	59	24	52	57

Computed by Drs. Copeland and Lohse, at Dun Echt Observatory, from observations at Vienna and Dun Echt.

The following elements have kindly been furnished by Prof. Ormond Stone, of Cincinnati:—

T = August 19.202.

	°	′	″
ω =	122	30	21
Ω =	98	42	41
i =	141	35	2

log. q = 9.79590.

Science Observer Special Circular No. 16

THE following simple electrical experiment is described in *L'Electricien*. A small box of pasteboard is closed with a lid of fine glass, on the upper surface of which collodion is applied several times (but not so much as to render the lid opaque). In the box are placed insect forms, made of sponge or cotton. On rubbing the collodion surface with dry fingers, in dry weather, the insects move about in a curious manner.

PHOTO-MICROGRAPHY.

By DR. CARL SEILER.

All workers in microscopy, doubtless, appreciate the necessity of correctly recording, not only in writing, but also by means of pictures or drawings, many of the appearances seen in the field of the microscope. We can do this by drawing an outline of the objects observed, by the aid of the *camera lucida* ; but not only does this require some practice, but also a considerable amount of time, and even then the resulting picture will not be a correct representation of the field of the microscope, because it will always be tinged more or less by the imagination of the draughtsman, and will be more or less diagramatical in consequence.

With photography, on the other hand, an exact reproduction of the image thrown upon the screen can be obtained, and in much less time than it takes to make even a comparatively simple drawing with the *camera lucida*. It is the object of this chapter to give an idea of the means employed to obtain a photographic picture of a microscopic object—means which are in the hands of every microscopist, and which do not require a great outlay of money.

A room with a southern exposure, which can be darkened; a mirror, movable in all directions, outside of the window; an achromatic combination of lenses of from eight to ten inches focal length; a microscope which can be tilted so as to be horizontal, and a stand to hold the screen and sensitive plate, are all the apparatus absolutely necessary besides the chemicals used in ordinary photography.

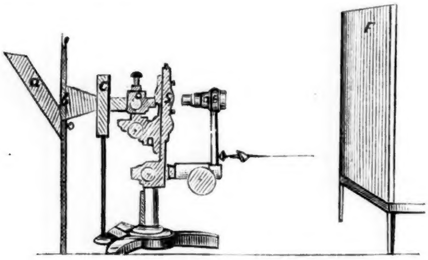


FIG. 1.

These different pieces are disposed of as follows (FIG. 1): The mirror (*a*), which should be eight or ten inches long by about four inches wide, is attached to a board which fist into an opening in the dark shutter of the southern window, and is to be moved by rods from the inside. Instead of this mirror, or in conjunction with it a heliostat is of great advantage to throw the light of the sun constantly in one direction, for, if once adjusted, it need not be disturbed, and thus a great deal of time is saved. Until recently such an instrument was too costly for the use of students, but of late Mr. Kuebel, of Washington, D. C., has put a heliostat in the market which works very satisfactorily and which is sufficiently low in price to be within the reach of many who desire to work in photo-micrography. The board in the shutter has in its centre a circular opening containing an achromatic combination of lenses (*b*), such as the back combination of a one-fourth portrait photographic lens.

The microscope is secured on the window-sill in a horizontal position, so that the axis of the tube is in a line with the axis of the achromatic combination, and at such a distance from it that the burning focus is about half an inch from the back combination of the sub-stage condenser (*d*). The eye piece is then removed from the microscope, and the tube lined with black velvet, to prevent internal reflection, as far as possible, and the whole apparatus is covered with dark cloth, to prevent stray rays of light entering the darkened room. This done, the sun's rays are reflected from the mirror outside the window, through the achromatic combination, which acts as a concentrator and throws a powerful light through the condenser, through the object on the stage (*s*), and thus a brightly illuminated image is formed by the objective (*o*) on the screen, which latter, when the negative is to be taken, is replaced by the sensitive plate.

This image, when thus formed, must be focused with the greatest care and accuracy, in order to obtain a sharp negative; and as the screen must be at some distance from the microscope in order to obtain the necessary magnification of the object, it is necessary to have some contrivance for turning the fine adjustment at a distance. For this purpose it will be found that a small pulley, placed alongside of the microscope, having an endless band running over it and the milled head of the fine adjustment, answers the purpose very well, when the axis of the pulley is connected by means of a universal joint to a fishing-rod, which by its sections can be made longer or shorter, thus bringing its end close to the screen.

The tube of the microscope, even when all internal reflection has been obliterated, still remains a drawback, inasmuch as it reduces the size of the image, or rather the disk of light, the more, the longer it is. There are, however, some stands made in which the tube can be entirely removed, such as the old Ross stand, and they are therefore very desirable for photo-micrographic purposes.

Any good objective of wide angular aperture and good definition can be employed for photography, provided monochromatic light is used in making the negative. When such is the case the visual and chemical foci fall in the same plane and a special correction of the objective for photography becomes unnecessary.

Such a light is obtained by passing the rays of the sun through a cell containing a strong solution of ammonio-sulphate of copper (*c*) before they enter the sub-stage condenser. I have found some difficulty in making the cell containing this solution, as the copper salt will dissolve almost any cement, and if exposed to the action of the air, very rapidly becomes decomposed, and the solution is thereby rendered useless for the purpose. I have used with satisfaction a cell made of a brass ring, lined on its inner side with lead or tin, having a thread cut on its outside, to which flanged rings are secured. Upon the edges of the inner ring a ring of rubber packing is applied, and upon it a disk of plate glass is laid, which is tightly pressed upon the rubber by the flanged ring. Thus a cell is obtained very similar to the round, flat spirit levels, and which will hold the ammonia sulphate of copper solution for months without change. In filling the cell care should be taken to leave room for a small air bubble, for if the cell is completely filled the heat of the sun's rays will expand the solution sufficiently to cause leakage.

This solution, besides giving monochromatic light, at the same time filters out almost all the heat rays from the light, so much so that an immersion lens may be used for any length of time without the drop of water evaporating.

At the present time, when dry plate photography has been developed to such an extent that it has superseded, in a great measure, the wet process, it has been thought that it would be the most simple, economical and satisfactory for photo-micrography; but after repeated trials by myself, as well as many others working in the same direction, it has been found that it is not only more expensive, but also takes more time, in the long run. The reason of this is that it is impossible to judge, with any degree of certainty, as to the actinic power of the light forming the image on the screen by merely looking at it, and that a trial plate only will give an idea of the length of exposure necessary for a given day, time of day

objective, and subject, to be photographed. It is true we can expose a dry plate for trial, but then we must develop it immediately, and the time of developing a dry plate is about three times that of developing a wet one, and a dry plate is also about three times as costly as a wet one. Therefore the old wet collodion process is the best.

The collodion to be used should be an old one, and contain some free iodine. I have found that a mixture of "Anthony's red labeled" and "McCollin's delicate half-tone" collodions—both commercial articles—some five or six months old, gives very satisfactory results. The nitrate bath should contain forty grains of nitrate of silver to the ounce of water, and should be slightly acidulated with nitric acid. The developer should be a weak one: twelve to fifteen grains of the double salt ammonio-sulphate of iron to the ounce of water, containing a few drops of a solution of gelatin and acetic acid as a restrainer.

After the negative has been fixed in the usual way, with hyposulphite of soda or cyanide of potassium, it is almost always necessary to intensify it, which is easily done by flowing the plate while wet with a watery solution of iodine until the film becomes white; then it is to be washed under the tap and flowed with a solution of sulphide of ammonium, which imparts to the negative a dark brown color, and thus strengthens its printing quality.

The object to be photographed should be as thin as possible, because the lens will depict only one plane of it, and it should present as much contrast and differentiation of its elements as possible; this is especially the case in animal tissues, and when high powers are used, the focus should be taken with the greatest care *for one particular point to be brought out*; a general focus not particularly sharp in any one point, will not give a satisfactory negative.

The screen upon which the image is focused should be of plate glass, having an extremely fine ground surface on one side—the side next to the object. Such a surface can easily be prepared by flowing the glass plate with a good negative varnish, and when this is set but not yet dry, lightly breathing on it, when an extremely fine and even frosting of the surface will show itself, sufficient to arrest and reflect the rays of light forming the image.

In photo-micrography, as well as in ordinary microscopy, proper illumination of the object is of the greatest importance, and frequently a poor objective will show a better definition in the hands of a skilled manipulator than the best objective can when the light is not properly managed. In this one point lies the difficulty of photo-micrography, and it is the stumbling block over which so many fall who undertake to photograph microscopic objects.

As a general rule the best light is obtained when the back lens of the sub-stage condenser is about half an inch beyond the burning focus of the larger condenser in the shutter, that is about eight and a half inches from this condenser, and when the light is *absolutely central.* But this distance cannot be strictly adhered to, inasmuch as different objectives require different illumination. In practice, I find that in order to obtain the proper distance of the condenser for a particular objective, it is best to put a blood-slide, upon which the corpuscles are in one layer only, on the stage, and project the image on the screen, moving the condenser backward and forward until, when sharply focused, no concentric rings are seen in the disks. The object to be photographed can then be substituted for the blood-slide, and the light will be found to be all that is desired. *(Compendium of Microscopical Technology.)*

PROFESSOR HELMHOLTZ will issue a collection of his scattered scientific memoirs in the autumn.

PLANTÉ AND FAURE BATTERIES.

The annexed illustrations of the secondary batteries, which are exciting so much interest at the present time will, with the accompanying description, enable the reader to understand their construction. At the recent soirée given by the Council and academical staff of King's College, several forms of electric-lighting apparatus were used; but that which attracted most attention was a battery of forty-four accumulators of Faure's design, working twenty of Swan's lamps. The cells were charged in Paris by a Gramme machine, and were arranged in groups of four in cubical boxes, the whole being coupled up in series. The current supplied by this arrangement, shown by a galvanometer in the circuit while the lamps were alight, was about twenty-three webers, and was perfectly steady—the Faure battery yielding an almost equal current during the whole time, until the charge becomes exhausted, when it breaks down suddenly, without any noticeable warning. Mr. Spottiswoode also uses the Faure battery to work Swan

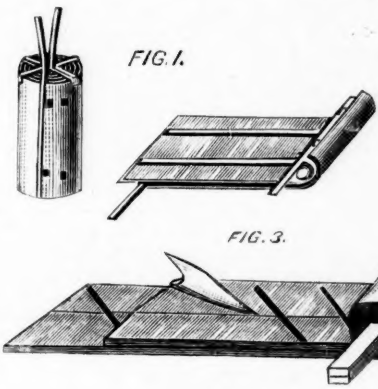


FIG. 1.

and Maxim lamps in his private house. Figs. 1 and 2 represent the Planté cell. The preparation is as follows: Two sheets of lead (it may be as thin as stout lead-foil) are laid the one on the other, separated by two strips of india-rubber, the whole being rolled up as shown in Fig. 1. The roll having been completed, the cylinder used in its formation is withdrawn, and it is consolidated by a wrapper of gutta-percha, and inserted in a glass jar filled with water and 1-10th part acid. An electric current is then made to pass through the cell; oxygen is given off, and produces a thick cushion of peroxide of lead on one sheet; hydrogen is given off at the other sheet. If the current with which the cell has been charged be cut off, and the two sheets are connected, a current will be produced, owing to the presence of the oxygen, which leaves the sheet where it has accumulated and attacks and oxidises the other sheet. This secondary current, which is very small at first, gains strength each time the operation is repeated; in course of time the surfaces of the sheets are changed, the one being covered with a cushion of peroxide of lead, the other with lead reduced to a spongy mass. The cell is then complete, and in a state of electrical accumulation. That was Planté's first successful battery. Subsequently he tried the plan of separating the two sheets of lead by canvas, the cell taking the form of Fig. 2. He then found that it was necessary to leave a small space between the sheets to provide for the escape of the gases which were produced at the end of the charge; subsequently india-rubber bands were employed in preference to canvas. M. Planté also tried carbonate of lead, minium, &c., but without improving upon the results already obtained. The

FIG. 2. FIG. 4.

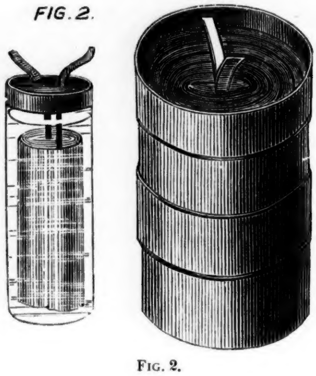


FIG. 2.

Faure battery is similar to the above:—Two sheets of lead are taken, about 7½in. wide; one about 23in. long and about 1-25th of an inch thick, the other 15in. long and 1-48 in. thick. Each of these is furnished with a strong strip of lead at one of its ends. Each sheet has a layer of red lead spread on its surface, the lead being made into a paste with water, the larger sheet having about 800 grammes on its surface, and the smaller 700 grammes. On each surface a sheet of parchment is laid, and the whole is introduced into a sheathing of thick felt. The sheets are laid one above the other; at the same time several bands of india-rubber are placed in an oblique fashion, as shown in Fig. 3. The roll is placed in a leaden jar strengthened by copper bands, and covered in the interior with red lead and felt. The cell then presents the appearance shown in Fig. 4. One of the pieces of lead which jut out is curved and soldered to the outer jar, acidulated water is put in, and the battery is ready for work.

We give the above figures as a guide, but there is no special reason for adhering to them, and it may be doubted whether either the parchment or felt is an absolute necessity; for good batteries have been constructed by painting stout lead-foil with red lead made into paste with water slightly acidified with oil of vitriol, and wrapping the plates in flannel or canvas which has been previously coated with the red lead paint. The painted surfaces are of course put together. Thin lead is used to keep the weight down as much as possible and to reduce the cost.

THE LESSON OF THE COMET; DOES IT SHOW A NEW FORCE?

By SAMUEL J. WALLACE, Washington. D. C.

There is one important consideration in relation to a comet and its tail which does not seem to have been properly noticed. A comet is generally supposed to be a mass, cloud or assembly of masses, particles and possibly gases, which travel together through the heavens, but do not actually form a single cohering body.

Now the remarkable point is this. When this assembly of matter of various sizes and conditions approaches the sun at a great velocity it seems to be acted upon by two forces in opposite directions at the same time, the one driving it forward toward the sun and the other driving it out away from the sun, and apart laterally.

And these two forces seem to act at different rates on different parts of the matter, so as to drive some parts forward, forming the head of the comet; to drive other parts forward with a less force, and spread them apart, forming the brighter part of the tail; while they act to actually drive other parts away into space, as the brush of the tail.

This is an action like that familiar to us in concentrating ores and in separating grain from the chaff. When ores are powdered fine and sifted down a shaft, up which a strong current of air is blown, the heaviest and richest particles fall through the opposing current to the bottom while the lighter and worthless particles are blown up and away. In this manner the rich ore is separated from the poor, and in a like way grain is separated from the chaff. This occurs because there are two forces acting against each other—the wind and gravitation—which act at different rates on the different particles and separate them.

The comet looks as if it was undergoing this very operation of concentration, or separation of the heavy parts from the light parts, under the action of gravity driving inward to the sun or some other opposing force driving outward and apart.

What makes this so remarkable is that the substance of the planets seems to have been separated in this very same manner. If we take the recognized specific gravities of the several planets and set them down in the order of their occurrence from Neptune, the furthest, inward to Mercury, the nearest the sun, beginning with one as the unit, we will find a gradual increase in weight per cubic foot from one for Neptune up to about nine for Mercury. If we set down the velocity of the planets in the same manner we will find the singular fact of an increase in the same way, from one for Neptune to about nine for Mercury. So that the velocity and the weight per foot increase together in a way that looks very suspicious of some connection between them.

What makes it look so singular is that the distance from the sun decreases almost in the very ratio of these two proportions multiplied into each other; or in the very way which it would do if the planets were formed of matter which had been concentrated by the heavy parts being driven toward the sun by gravity and the lighter parts being driven away by some other force—such as that which seems to be driving off the tail of the comet—so that each planet was formed of matter separated by its specific gravity in a general way, according to its distance from the sun and its velocity. Another thing which confirms this singularity is that the average weight of the meteoric masses which fall on to the earth, made up mostly of iron and some lighter rock, is very nearly that of the earth itself, taken as a whole, or about five and a half on the same scale, due to its position and velocity.

All this leads us to suppose that there is a force driving outward from the sun, as gravity drives toward it, but acting in proportion to the size of particles as gravity acts in proportion to their weight, which separates matter so that its average distance from the sun and its velocity shall conform to its average weight.

If this is true, as it seems, it throws light upon an obscure point, which may be considered as one of the most sublime within the reach of science; the nature of that wonderful mystery of gravitation itself, which holds and moves all the innumerable hosts of heaven in their everlasting circuits.

The course of modern thought is to render inconceivable the action of gravity as of an immaterial agent.

The theory of Lesage that it is the result of converging corpuscles of wave beats from all sides tending to drive bodies together is both sublime and in accordance with the habits of modern thought. But it utterly fails in one half of the problem. It does not explain what becomes of the dynamic energy of this force after it strikes a mass of matter, by which disappearance it is supposed to produce a shadow outward on all sides, to which the result of gravitation of masses to each other is attributed.

But if it should appear that there is a force thus going outward from the sun and other matter, as comets and planets in this way seem to indicate, then we are compelled to account for it also, which is the very force that Lesage's theory failed to show, and which his force requires for its complement.

This would require only to suppose the form of the force changed, in quantity proportionate to the quantity of matter, by passing through it, so as to act against particles in proportion to size, and to some other features, of which velocity and kind are elements, instead of in proportion to weight only, as before.

We cannot blame Lesage for overlooking the inconsistency of the utter disappearance of so much dynamic energy as his theory requires, because in his day the idea of the conservation of energy had not grown up; and it was a great, a sublime, grasp of thought, to conceive of a relation of mechanical action which was parallel in its nature to that utter, that bewildering, mystery of gravitation, which seemed as if it could only be due to the fiat or action of Creative Energy itself, acting forever and everywhere *de novo;* yet, at the same time, always with an absolutely steady and measured force and relation to quantity of matter, to distance in space, and to length of time, which indicated kinship in character to the other proximate and not ultimate forces of nature.*

But we cannot so easily overlook the failure of those who have later considered this theory to notice this great dynamic hiatus, and to follow it up to some conclusion.

These facts, stated, of the comets, of the planets, and of meteorites, indicate very clearly that there is a peculiar propulsive force acting outward from the sun.

And this force is of the general nature required to fill this hiatus.

Can we further determine anything of its nature?

We have already seen that it seems to act upon some kinds of matter in preference to other kinds; and that there seems to be different varieties of this selective difference caused by and in some proportion to velocity.

This last is a curious feature. How can velocity act to increase the action of a force on one kind of matter more than on another? Can any of the facts of ordinary knowledge give us any indications?

If we subject different substances to dry friction, electro-static disturbance is produced; the different kinds of substance will be acted upon differently, and perhaps the difference may be increased by the increase of the friction.

Now the condition shown in the comet is very much like that of an electrified body. But we must not jump to conclusions without examining the attendant conditions which would govern the facts.

We can suppose that the velocity of a body or assemblage of bodies through the ether, required to transmit light, or through a space containing other stray particles of matter, might produce a friction that would set up in it an electrified state; and which would be increased by increase of the velocity.

We can suppose that the light and electrical bodies, and the heavy metals would be electrified to different degrees; or at least that there would be different electric states produced,

And we can suppose that THE FORCES ACTING OUTWARD FROM THE SUN ACT ON PARTICLES IN SOME PROPORTION TO THEIR ELECTRIFIED STATES; and that on striking an assembly of particles it is reflected from their members, something like light is, in a great number of directions, which tends to drive them outward, and, in a less degree, to disperse them apart, as shown by the tail of the comet.

These suppositions show that the requirements which observation seems to call for have parallellisms within our knowledge, and indicate the course of new enquiries.

As a result of these and other considerations we may be led to infer that the growth of the solar system has been affected by such causes. That the heavy metals have, in coming into it, taken positions at last, very much dependant upon their weight and kind, in which respect the Earth, Venus and Mars, in their great interior masses, may represent the region of iron, while Mercury may represent the region of still heavier metals, and the outer planets the great mass of lighter substances; the average or mean distance of a body from the sun being governed inversely as the square of its mean velocity.

Thus a comet and its tail may become the missing link in astronomy and in science.

* We may believe that under the whole face and system of Nature there is an ultimate creative force which acts immediately each instant, to keep alive, to measure, and to guide, all of the actions and reactions taking place; but that is a conclusion and not a "knowledge." If it is true, yet it chances that the character of the action is such that we recognize all actions and reactions as taking place in chains having equality of links and certain peculiarities we call laws; which constitute proximate causes.

CORRESPONDENCE.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

To the Editor of "SCIENCE":—

I have been interested in reading Mr. Rock's account of his observation of the great Comet on the 6th of July. On that evening the comet was hidden at this Observatory by clouds until about ten o'clock, local time, when Mr. Wilson went into the dome to observe its position with the eleven-inch refractor. He soon returned, however, and called my attention to the remarkable appearance of the nucleus. I went to the dome and from that time until three o'clock we alternately examined the Comet, making sketches and measures. The fan had its usual appearance, but when first observed a bright red jet projected from the nucleus into the dark region on the side of the nucleus opposite the fan. This jet was totally different in appearance from those usually seen. It was at first straight and in brightness rivalled the nucleus itself; in fact at the first glance it seemed to form one with the nucleus. On a closer inspection, however, I saw that it had a transparent appearance but still intensely bright and red. The next glance showed that there was a dark line separating it from the nucleus. Mr. Wilson had already called my attention to this dark line before I went to the dome. During the first few minutes a decided change took place. The jet seemed to separate and form a nucleus of its own, so that for a time the comet appeared double; gradually, however, the detached portion grew fainter, until when last seen, at about three in the morning, although plainly visible, it was no brighter than the fan-shaped appendage on the opposite side of the nucleus. I noticed the band of light which Mr. Rock speaks of as connecting the "node" with the nucleus, and mentioned it to Mr. Wilson at the time, but this afterwards disappeared, leaving a separate mass floating like a cloud in the dark region opposite the fan.

There can be no question that a great outburst took place in the comet on that evening, nor that a portion of the nucleus became detached. The phenomenon was watched very carefully for five hours and I think I could hardly be mistaken in what I saw. ORMOND STONE.

CINCINNATI OBSERVATORY, *July* 19, 1881.

To the Editor of "SCIENCE."

In Mr. Rachel's reply, in No. 52, to my letter in No. 47 of "SCIENCE," he appears to entertain a different conception of the law of gravitation from that which I supposed to be usually entertained by astronomers. As there may be many others who share his view, it seems advisable to give a more detailed exposition of what I think was Sir Isaac Newton's own conception, and is that of many more recent astronomers.

Newton's law of gravitation is that "every particle of matter in the universe attracts every other particle with

a force that is directly proportioned to the mass of the attracting particle and inversely to the square of the distance between them." The first question arising is, what are we to understand by "particle" in this theory? Certainly not a mass of utterly indefinite size. Undoubtedly Sir Isaac meant a mass of unit size, since the very terms of the proposition require this. For if every particle attracts every other particle with a certain vigor, then it must necessarily attract two particles with twice the vigor with which it attracts one. Or if a particle of unit mass attracts another with unit vigor, then it must attract two others, or one other whose mass is double the unit vigor. And as each of these two others attracts it with the unit vigor, then their sum, or their double mass, must attract it with double the unit vigor. It is simply the principle, still elder than Newton in its expression, that "action and reaction are always equal and opposite."

But if it be granted that such will be the reaction between a unit and a double unit mass, the whole question is settled. For if the second mass may be doubled it may be quadrupled, or may be increased a million fold, without any difference in the principle. And likewise the first mass may be increased without affecting the principle. A mass of one unit attracts a mass of ten units with an energy equal to ten units, since it attracts each of the ten with unit energy. And each unit of the ten reacts on the one with unit energy, so that their combined attraction equals ten units. Again, if the first mass contain two units, each of these separately acts upon each of the ten with unit energy. Thus as each unit of the two exerts ten units of energy, the two together exert twenty units. In other words, the energy which the first mass exerts upon the second is proportioned to the product of the number of mass units in the first into the number of mass units in the second; and the action of the second upon the first also is in proportion to the product of their units.

This is the true principle of the attraction of gravitation. We may take the unit mass of any size we wish. In the action between the earth and the moon, for instance, we may take the mass of the moon as the unit, that of the earth being about 75 units. The moon will attract each unit of the earth with unit energy, and the whole earth with an energy of 75 force units. But each unit of the earth will react upon the moon with unit energy, and the whole earth will exert on the moon an energy of 75 force units. Thus the moon attracts the earth with precisely the same vigor as the earth attracts the moon. Of course the resulting motions are not the same, but the resulting momentums are precisely equal. As the earth is 75 times the weight of the moon a motion of one foot per second in the earth would give it a momentum equal to that given the moon by a motion of 75 feet per second. It is well known that the moon does not revolve around the centre of gravity of the earth, but that these two bodies revolve around their common centre of gravity. But this common centre is within the mass of the earth, and may be found by dividing the distance between the centres of the earth and moon by the ratio of their weights. If we take this distance as 240,000 miles, and divide by 75—the weight of the earth as compared with the moon—the common centre of gravity will appear to be 3200 miles from the earth's centre.

Or we might consider this case from the principle of inertia. The earth having 75 times the mass of the moon has 75 times the inertia, or resistance to exterior forces. Thus its movement in response to lunar attraction is only 1-75th that of the moon in response to terrestrial attraction. But its weight being 75 times greater, its momentum in response to lunar attraction must be precisely equal to the moon's momentum in response to the earth's attraction; or, in other words, their vigor of action upon each other must be precisely equal. This movement of the earth under the action of the moon does not affect the line of its orbital movement, since it is less than the length of the earth's radius. Its movement is like that of a bead with a large aperture, which advances along a string moving from side to side, but not leaving the string. But as the earth moves about 46 millions of miles in its orbit while completing one of these gyrations, the effect is excessively minute. That of the moon, in fact, which swings 240,000 miles to each side of the orbit each fortnight, is very slight when compared with the length of the orbit.

But if, the earth being 75 times the mass of the moon, it also attracted the moon 75 times more vigorously than the moon attracts the earth, this common centre of gravity would be found by dividing 240,000 by 75^2 and would be but 36 miles from the earth's centre. As to which of these results is the more correct the books will show.

I am, therefore, obliged to repeat the idea advanced in my former article. An atom falling towards the earth attracts it with as much energy as the earth attracts the atom, and they move toward each other with equal momentums. But the great weight of the earth reduces its rate of motion towards the atom to a speed inconceivably small, while the small weight of the atom gives it an excessively rapid speed towards the earth. It would be strange if, at this late date in the history of the theory of gravitation, I had been the first to advance this idea as Mr. Rachel seems to suppose. Perhaps my mode of presenting it may be original, but I can readily quote other expressions of the same idea. Thus Dr. Ball, Royal Astronomer of Ireland, speaks as follows, in his article on Gravitation in the new edition of the Encyclopedia Britannica: "It has been found that the intensity of the attraction of gravitation between two masses is directly proportional to the product of those masses." This is precisely the result I have reached in the above argument. Again he says: "Let m, and m' be the masses of two bodies, and let r be their distance. The force with which m attracts m' is equal in magnitude though opposite in direction to the force with which m' attracts m. The reader may perhaps feel some difficulty at first in admitting the truth of this statement. We speak so often of the effects which the attraction of the sun produces on the planets that it may seem strange to hear that each planet reacts upon the sun with a force precisely equal and opposite to the force with which the sun acts upon the planets." He illustrates as follows: "Suppose the earth and the sun to be at rest in space, and prevented from approaching each other under the influence of gravity by a rigid rod extending from one to the other. If now the sun pressed toward the earth more vigorously than the earth toward the sun the greater pressure of the sun must overcome the lesser pressure of the earth, and the whole arrangement would be driven through space in the direction in which the rod points outward from the sun. For there would be a motion producing vigor in the sun unopposed by a sufficient resistance in the earth. And yet, in the event of such a movement, we would have the kinetic energy of their motion created out of nothing, which is now well known to be impossible." Such is Dr. Ball's argument briefly stated. It leads to the same result as mine, and I therefore claim to be in full accord with the Newtonian law of gravitation.

In regard to the other points of Mr. Rachel's letter there is nothing on which I desire to dwell. As to the use of the phrase "Latent Heat," the scientific world will be very ready to give it up if a term can be suggested more significant of the character of the energy indicated. But there would be nothing gained by simply substituting one unmeaning name for another. Mr. Rachel himself uses the phrase "Radiant Heat," yet he must be aware that the mode of motion so called is very different from ordinary Heat Motion. Radiant Heat is readily convertible into Static Heat; but so is

Electricity; and we have the same warrant to consider Electricity as some modification of Heat. In fact the term "Radiance" would be a more distinctive appellation than "Radiant Heat."

As to trust in authorities, of course we must trust in them as long as their explanations seem most in accordance with facts, but no longer. Well-established facts are the only trustworthy data of Science. No theory can be sustained against the pressure of unconformable facts. In short, every theory is in danger while a single fact remains unexplained. For the facts of nature are so closely linked that each in some way bears upon all, and all upon each. And yet it is by no means advisable to stop theorizing, for correct theories are themselves facts of science—facts concerning forces and relations as deduced from facts concerning things. And every partially correct theory is a footstool through which higher levels of conception may be reached; while every theory proved incorrect is a warning board, advising all future scientists not to waste time in following a path that leads nowhere.

CHARLES MORRIS.

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BOOKS RECEIVED.

TEXT-BOOK OF EXPERIMENTAL ORGANIC CHEMISTRY for Students, by H. CHAPMAN JONES. D. Van Nostrand. New York, 1881.

Although termed a text-book, the author admits that this little volume will be found of greater use as a companion for the student in the laboratory, who wishes to study organic chemistry both practically and theoretically.

We recommend this volume to those who have a limited time at their command for study, and are not overburdened with cash, the author having wisely restricted the number of experiments, and suggested only such as are available in a laboratory of the humblest pretensions, and the use of expensive chemicals is altogether avoided. The author has shown considerable judgment in arranging this work, the plan of which is excellent, because while the subject has been reduced to its simplest form, the instructor will find all that is necessary for teaching the elementary stages of practical organic chemistry, and it will serve as a reliable guide to the average student who relies on his own resources for instruction.

CONTRIBUTIONS TO METEOROLOGY: being results derived from an Examination of the Observations of the United States Signal Service, and from other sources. By ELIAS LOOMIS, Professor of Natural Philosophy in Yale College.

A pamphlet reprinted from the *American Journal of Science*, being the subject matter of a paper read before the National Academy of Sciences. Washington, April 19, 1881.

ON THE GROUP "*b*" ON THE SOLAR SPECTRUM. By WILLIAM C. WINLOCK. From the proceedings of the American Academy of Arts and Sciences. Presented by Professor Wolcott Gibbs. June 9, 1880.

The most complete charts of the solar spectrum now available are Kirchhoff's, which were published in 1861, and Angström's, published in 1869. Kirchhoff employed a battery of four flint-glass prisms, with a collimator and observing telescope each of about 4 centim. aperture and 49. centim focal length; while Angström used telescopes of about 4.6 centim. aperture, and 36.3 centim. focal length, and a diffraction grating made by Nobert, containing about 133 lines to the millimetre.

Such great advances have been made very recently in the construction of optical instruments, and more especially in the ruling of diffraction gratings, that it would now be possible to enlarge Angström's great chart almost as much as he improved upon Fraunhofer's first maps. But it would be an almost endless undertaking for a single observer to attempt a map of the whole spectrum, from the ultra-violet to the invisible red, brought to light by our most powerful instruments, and accordingly most physicists who have paid especial attention to solar spectroscopy have devoted themselves to a careful study of detached portions which appear of unusual interest. As a contribution to this work, the following observations upon the group of dark lines "*b*," of the solar spectrum, were undertaken by Mr. Winlock, at the suggestion of Dr. Gibbs, and carried on under his immediate supervision.

A PRACTICAL TREATISE ON THE MANUFACTURE OF STARCH, STARCH-SUGAR AND DEXTRINE, based on the German of Ladislaus Von Wagner and other authorities, by JULIUS FRANKEL. Edited by Robert Hutter. Illustrated by 58 engravings, covering every branch of the subject. Henry Carey Baird & Co., 810 Walnut street, Philadelphia, 1881. Price, $3.50.

The increased manufacture of Glucose and the prospect of this substance becoming a staple article of produce in the United States, makes this volume a welcome addition to the excellent series of technical works published by this house.

Those about to engage in the manufacture of Glucose will find this treatise an indispensable guide, and, as we understand, it is the only work in the English language describing in detail the processes and machinery made use of in this important class of industry.

It is stated in the preface that this subject has been heretofore surrounded by more or less mystery than any other manufacture of recent years, and that access to factories has been barred to all but workmen, and that inventors and manufacturers of the necessary machinery have refused to furnish drawings of the machines. It is therefore evident that the present work, which has been prepared with care, intelligence and zeal by one who is a master of the subject, must be a valuable acquisition to those interested in this industry.

Mr. Frankel introduces the subject by describing the Chemistry of Starch, its technology and methods of manufacture. The Chemistry of Starch-sugar is then taken up and its manufacture in all its branches explained in detail. The author concludes with an exhaustive description of Dextrine and its manufacture.

It was Professor Kirchhoff, of St. Petersburg, Russia, who made the important discovery in 1811, that starch boiled in diluted sulphuric acid is transformed into sugar, but the origin of glucose manufacture dates from the time of Napoleon I., when the English were blockading the Continent. At the time it caused a great and general sensation, as it was then thought that grape sugar was identical with cane sugar, and hence could in every respect be substituted for that product. This new branch of industry was, therefore, pursued with energy, and immense quantities of starch-sugar were manufactured, but subsequently, when it was proved that this material was by no means identical with cane sugar, being less soluble, of less sweetness, and not at all suitable to serve as a substitute for the former, then for a number of years the demand ceased. Of late years a revival has taken place in this industry, and in 1876 Germany alone produced in her 47 glucose, starch-sugar and syrup factories 100 million pounds, and as we stated in a recent article 500 tons a day of glucose are now produced in the United States.

It is singular to observe that such substances as Starch, Grape-sugar and Cane-sugar, which have such opposite properties in some respects, are almost chemically alike. If starch absorbs two molecules of water, it becomes transformed into glucose (grape or starch sugar), while cane sugar contains one molecule more than starch and one molecule less than the starch sugar. The chemical

composition of these substances may be compared by arranging their formulæ in the following manner:

$$C_{12}\ H_{20}\ O_{10},\ \text{or}\ C_{12}\ H_{10}\ O_{10} = \text{Starch.}$$
$$C_{12}\ H_{22}\ O_{11},\ \text{or}\ C_{12}\ H_{11}\ O_{11} = \text{Cane Sugar.}$$
$$C_{12}\ H_{24}\ O_{12},\ \text{or}\ C_{12}\ H_{12}\ O_{12} = \text{Grape Sugar.}$$

Grape-sugar is largely diffused throughout the animal kingdom, and is found in most of the sweet tasting fruits. It is contained in the honey of the bee, and is separated in large quantities in the urine of those unfortunates who suffer from that disease of the kidneys called *diabetes mellitus*. Grape-sugar is not only found in nature but can be produced chemically. Thus it is formed as a result of the action of diluted acids, diastaste, gluten, saliva, etc. on starch, and for this reason starch is used for its production on a large scale.

The fullest directions are given in this work for the manufacture of glucose from starch, and we congratulate the publishers on producing a book at a moment so *apropos*, and we regret we cannot devote more space to the subject; we advise, however, all interested in this new and rising industry to obtain a copy of the work, for it apparently presents all the facts bearing on the manufacture of glucose, in a very convenient form.

REPRODUCING DRAWINGS, DESIGNS, &c.

The following method of reproducing drawings, &c., in any desired color, has been patented by M. M. Tilhet, of 18 Rue de la Paix, Paris. The paper upon which the design is to be reproduced in order to prepare a negative copy is first passed through a bath composed of the following materials in about the proportions given: White soap, 30 parts by weight; alum, 30 parts; Flanders glue, 40 parts; the white of eggs or albumen beaten up, 10 parts; glacial acetic acid, 2 parts; alcohol at 60 degrees, 10 parts; water, 500 parts. The paper, after having been removed from this bath, is passed through a second bath composed as follows: Burnt umber, ground in alcohol, 50 parts by weight; black pigment, 20 parts; Flanders glue, 10 parts; water, 500 parts; bichromate of potash, 10 parts. The paper having been thus treated must be kept when dry in a dark place. In order to prepare positive paper for the prints, a bath is used similar to the last, but without the umber, for which black pigment is substituted. Or, if it is desired to obtain colored proofs instead of black ones, the black pigment is replaced by a pigment of red, blue, or any other desired color. To prepare the copies, the design or drawing is placed in an ordinary photographic printing frame, the back of the design being next to the glass, and a sheet of negative paper prepared in the way first described is placed in contact with it. The frame is then exposed to light, two minutes exposure being sufficient in good weather. The sensitive paper is then removed from the frame in a dark place and is placed in water, when the design becomes visible in white, and the paper is then allowed to dry. In order to obtain positive pictures from the negative thus prepared, the latter is placed in the printing-frame with a sheet of the positive paper prepared in the manner above described in contact with it, and after exposure to light for a sufficient time, that is to say, about two minutes, the positive paper is removed in a dark place, and is plunged into water, which removes the part of the pigment which has not been affected by the light, without its being necessary to touch it. Any number of copies of the design or drawing may be produced by the novel method described upon any kind of paper, and in any color or colors. The proportions of the different materials used to prepare the baths as above described may be varied to suit varying circumstances, such as the weather and the character of the design or of the paper.

METEOROLOGICAL REPORT FOR NEW YORK CITY FOR THE WEEK ENDING JULY 23, 1881.

Latitude 40° 45′ 58″ N.; Longitude 73° 57′ 58″ W.; height of instruments above the ground, 53 feet; above the sea, 97 feet; by self-recording instruments.

JULY.	BAROMETER. Mean for the day. Reduced to Freezing.	Maximum. Reduced to Freezing.	Maximum. Time.	Minimum. Reduced to Freezing.	Minimum. Time.	THERMOMETERS. Mean. Dry Bulb.	Mean. Wet Bulb.	Maximum. Dry Bulb.	Maximum. Time.	Maximum. Wet Bulb.	Maximum. Time.	Minimum. Dry Bulb.	Minimum. Time.	Minimum. Wet Bulb.	Minimum. Time.	Maxi'm In Sun.
Sunday, 17	29.579	29.618	0 a. m.	29.508	5 p. m.	73.6	66.6	81	2 p. m.	72	2 p. m.	64	12 p. m.	60	12 p. m.	131.
Monday, 18	29.523	29.596	0 a. m.	29.446	4 p. m.	69.3	61.3	74	4 p. m.	63	4 p. m.	62	6 a. m.	59	6 a. m.	126.
Tuesday, 19	29.611	29.690	12 p. m.	29.542	0 a. m.	74.7	65.0	84	3 p. m.	68	4 p. m.	66	6 a. m.	60	6 a. m.	130.
Wednesday, 20	29.686	29.742	9 a. m.	29.632	12 p. m.	77.3	68.0	83	5 p. m.	71	5 p. m.	69	6 a. m.	65	6 a. m.	123.
Thursday, 21	29.553	29.638	12 p. m.	29.500	2 p. m.	78.3	69.3	87	3 p. m.	72	2 p. m.	69	12 p. m.	64	12 p. m.	135.
Friday, 22	29.596	29.638	0 a. m.	29.546	6 p. m.	73.3	66.0	77	3 p. m.	69	6 p. m.	66	5 a. m.	62	6 a. m.	127.
Saturday, 23	29.646	29.722	12 p. m.	29.586	3 a. m.	72.0	65.7	79	3 p. m.	68	3 p. m.	65	5 a. m.	61	5 a. m.	139.

Mean for the week .... 29.599 inches.
Maximum for the week at 9 am., July 20th .... 29.742 "
Minimum " at 4 pm., " 18th .... 29.446 "
Range .... .296 "

Dry. Wet.
Mean for the week .... 74.0 degrees .... 65.9 degrees.
Maximum for the week, at 3 pm. 21st 87. " at 2 pm 21st, 72. "
Minimum " " 6 am. 18th 62. " at 6 am 18th, 59. "
Range " " .... 25. " .... 13. "

JULY.	WIND. Direction. 7 a. m.	Direction. 2 p. m.	Direction. 9 p. m.	Velocity in miles. Distance for the Day.	Force in lbs. per sqr. feet. Max.	Force. Time.	HYGROMETER. Force of Vapor. 7 a. m.	Force of Vapor. 2 p. m.	Force of Vapor. 9 p. m.	Relative Humidity. 7 a. m.	Relative Humidity. 2 p. m.	Relative Humidity. 9 p. m.	CLOUDS. Clear, 0 Overcast, 10. 7 a. m.	Clouds. 2 p. m.	Clouds. 9 p. m.	RAIN AND SNOW. Depth of rain and snow in inches. Time of Begining.	Time of Ending.	Duration. h. m.	Amount of water	OZONE. 1 10
Sunday, 17	w. n. w.	w. n. w.	n. n. w.	217	6	4.40 pm	.537	.663	.495	71	63	70	3 cir. cu	2 cir. cu.	0	-----	-----	-----	--	4
Monday, 18	n. w.	w. n. w.	w. n. w.	238	9½	11.40 am	.433	.429	.449	73	51	61	1 cir.	7 cir. cu.	0	-----	-----	-----	--	2
Tuesday, 19	w. n. w.	n. w.	w.	219	6½	1.50 pm	.457	.460	.554	69	42	64	0	1 cir. cu.	0	-----	-----	-----	--	1
Wednesday, 20	w.	w. s. w.	s. w.	156	2¼	1.30 pm	.537	.534	.612	71	49	62	4 cir. cu	3 cir. cu s	10	-----	-----	-----	--	1
Thursday, 21	w. s. w.	n. w.	n. n. w.	227	4¾	3.20 pm	.614	.609	.568	68	51	67	3 cir. cu	4 cir. cu.	0	-----	-----	-----	--	8
Friday, 22	n. w.	n. n. w.	n. n. e.	82	1½	8.50 pm	.495	.564	.568	70	61	67	2 cir.	9 cu.	0	-----	-----	-----	--	8
Saturday, 23	n.	n. e.	n. n. w.	140	2	2.30 pm	.489	.564	.595	74	61	76	8 cir. cu	4 cir. cu.	1 cir. s.	-----	-----	-----	--	1

Distance traveled during the week .... 1279 miles.
Maximum force .... 9½ lbs.

Total amount of water for the week .... 0 inch.
Duration of rain .... 0 hours 0 minutes.

DANIEL DRAPER, Ph. D.
Director Meteorological Observatory of the Department of Public Parks, New York.